Area Source Inventory Development

Residential Wood Combustion

Section 5; Part II

Randy Strait
E.H. Pechan & Associates, Inc.

How are RWC Emissions Estimated in the '99 NEI?

- **Focus**
  - How are RWC emissions estimated in the NEI?
  - How can the NEI for RWC be Improved?
- **Overview**
  - SCCs
  - Pollutants
  - Emission Factors
  - Activity Data (Top-Down Approach)
    - Method estimates national activity by type of device
    - Spatial allocation of national activity to counties
    - Rule effectiveness, rule penetration, & control efficiency
    - Temporal allocation of emissions

How are RWC Emissions Estimated in the '99 NEI?

- **SCCs**
  - **FIREPLACES**
    - 2104008001 Without Inserts
    - 2104008002 With Inserts; Non-EPA Certified
    - 2104008003 With Inserts; Non-Catalytic, EPA Certified
    - 2104008004 With Inserts; Catalytic, EPA Certified
  - **WOODSTOVES**
    - 2104008010 Non-EPA Certified
    - 2104008030 Catalytic, EPA Certified
    - 2104008050 Non-Catalytic, EPA Certified

How are RWC Emissions Estimated in the '99 NEI?

- New Source Performance Standard (NSPS)
  - 40 CFR Part 60, Subpart AAA, promulgated in 1988
  - Requires that all woodstoves sold after July 1, 1988 be certified by procedures specified in rule
  - Rule does not cover fireplaces without inserts
- What is an Insert?
  - Term covers many types of devices, ranging from
    - A device that is almost a free standing woodstove that sits inside the fireplace, to
    - To a conventional fireplace with tubes above the flames and a fan that blows the heated air into the room

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- Until 1999 NEI (Version 1.5), the NET/NEI included emissions from all woodstoves and fireplaces under SCC 210408001 (fireplaces without inserts)
- For 1999 NEI (Versions 1.5 & 2.0), RWC estimates based on revised methodology
- For the draft 1999 NEI (Version 2.0), EPA incorporated S/L/T SCCs and emissions and removed EPA emission estimates for SCC 210408001
  - See area source documentation for draft 1999 NEI for details (ftp://ftp.epa.gov/EmisInventory/draftnei99ver2/criteria/documentation/)

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- **Pollutants**
  - **PM10-PRI, PM25-PRI, NO_x, CO, VOC, SO_x**
  - **HAPs (number of pollutants)**

Fireplaces	**Woodstoves**
2104008001 (2)	2104008010 (25)
2104008002 (25)	2104008030 (25)
2104008003 (28)	2104008050 (28)
2104008004 (25)	

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

Emission Factors for <u>Fireplaces Without Inserts</u>

(lbs poll./ton of dry wood)

- **References**
  - NO_x, SO_x, VOC, & HAPs
    - AP-42, Chapter 1.9, Table 1.9-1
  - PM10-PRI, PM25-PRI, & CO
    - Houck, J.E., et al, "Review of Wood Heater and Fireplace Emission Factors," NEI Conference, May 1-3, 2001 (this article is on your CD)
    - Based on test data more current than AP-42
    - PM25-PRI assumed to be same as PM10-PRI

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

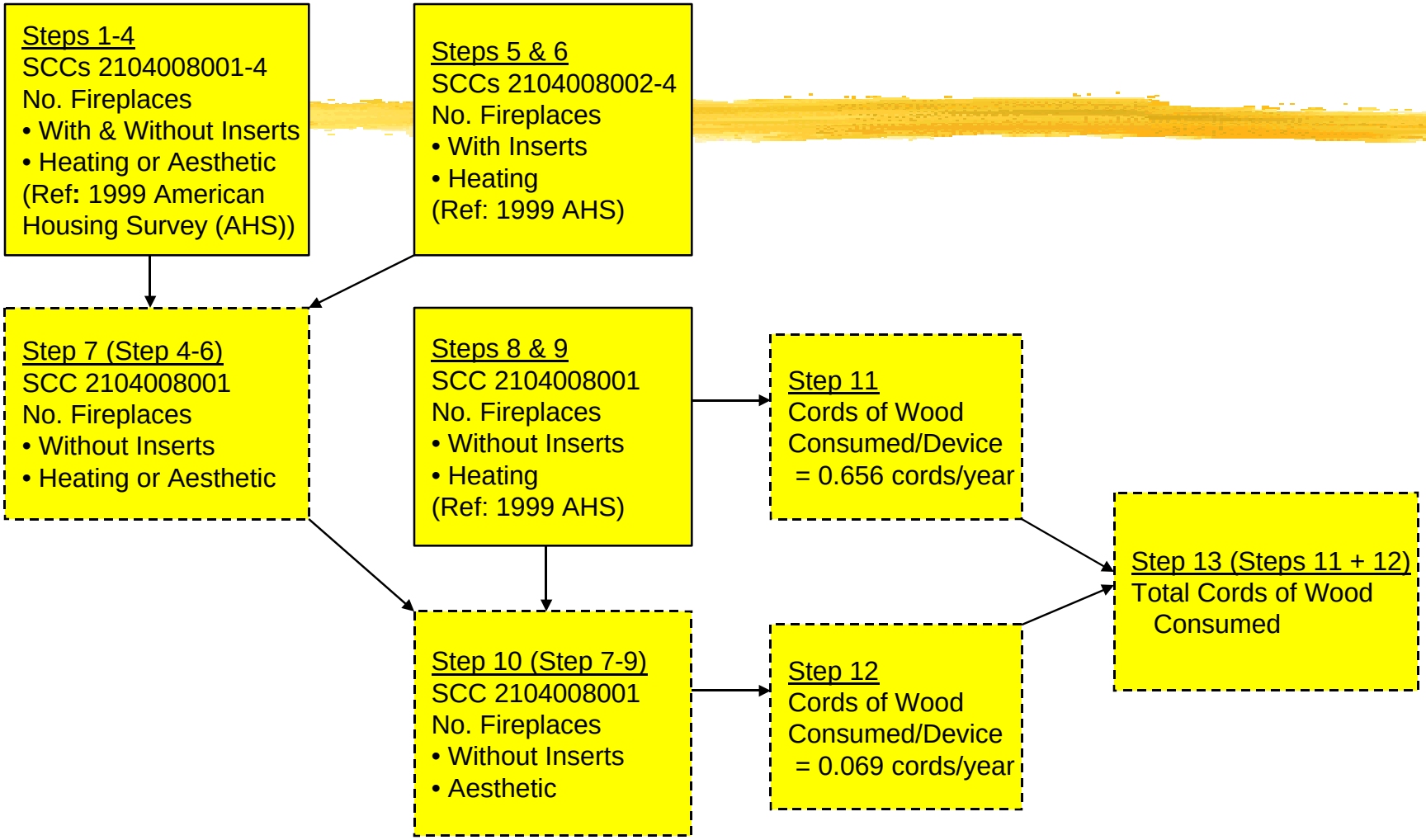
Emission Factors for Woodstoves & Fireplaces With Inserts (lbs poll./ton of dry wood)

- **Criteria Pollutants:** AP-42, Chapter 1.10, Table 1.10-1
  - PM10-PRI, PM25-PRI, & CO EFs are average for all woodstoves
  - PM25-PRI assumed to be same as PM10-PRI
- **HAPs:** AP-42, Chapter 1.10, Tables 1.10-2, -3, & -4
  - AP-42 EFs for Polycyclic Aromatic Hydrocarbons (PAH) reduced by 62% based on recent test data (Houck, et al, 2001)
- **Conversion Factor:** One cord of wood equals 1.163 tons

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- **Activity Data**
  - Develop separate national wood consumption estimates for fireplaces with inserts, fireplaces without inserts, & woodstoves to account for:
    - Different emission factors
    - Different usage patterns (climate zones; urban vs. rural)
  - National wood consumption estimated using:
    - Number of combustion units
    - Average wood consumption rates
  - Spatial allocation of wood consumption to county level performed to reflect usage patterns

Flow Chart for Estimating Activity for Fireplaces Without Inserts



Reference: Houck, J.E., et al, A Recommended Procedure for Compiling Emission Inventory National, Regional and County Level Activity Data for the Residential Wood Combustion Source Category, NEI Conference, May 1-3, 2001

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

National Number of Fireplaces Without Inserts

- **Step 1:** Determine national number homes with usable fireplaces (with and without inserts)
  - Reference: American Housing Survey (AHS) for the United States in 1999 (U.S. Census Bureau)
- **Step 2:** Adjust to account for homes with more than one fireplace (multiply Step 1 by 1.17)
  - Reference: 1989 U.S. Consumer Product Safety Commission report
- **Step 3:** Adjust for fireplaces that burn wood (74% wood, 26% gas)
  - References: Industry trade associations/experts, market surveys (Houck, et al, 2001)
- **Step 4:** Subtract out fireplaces not being used (42% not used)
  - References: Local surveys, industry market surveys, government publications (Houck, et al, 2001)

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

National Number of Fireplaces Without Inserts (Cont.)

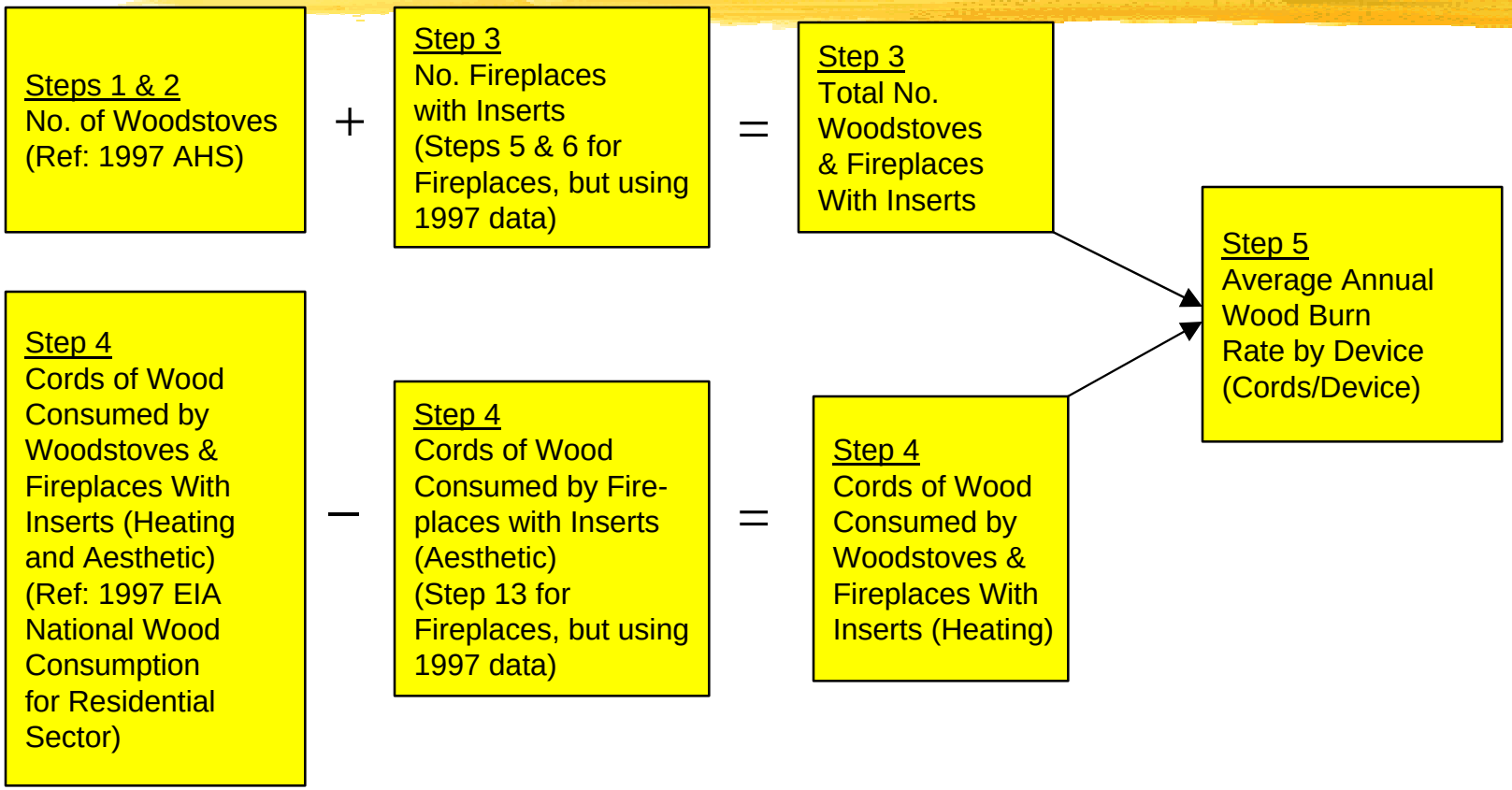
- **Step 5:** Determine number of homes with usable fireplaces with inserts used for heating
  - Used to determine the number of homes with usable fireplaces without inserts
  - Reference: AHS for the United States in 1999 (U.S. Census Bureau)
- **Step 6:** Adjust to account for homes with more than one fireplace (multiply Step 5 by 1.10)
  - Reference: 1989 U.S. Consumer Product Safety Commission report
- **Step 7:** Determine number of fireplaces without inserts used for heating and aesthetic purposes (Step 4-Step 6)
- **Steps 8-10:** Separate fireplaces into two categories:
  - Heating purposes
  - Aesthetic purposes

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

National Number of Fireplaces Without Inserts (Cont.)

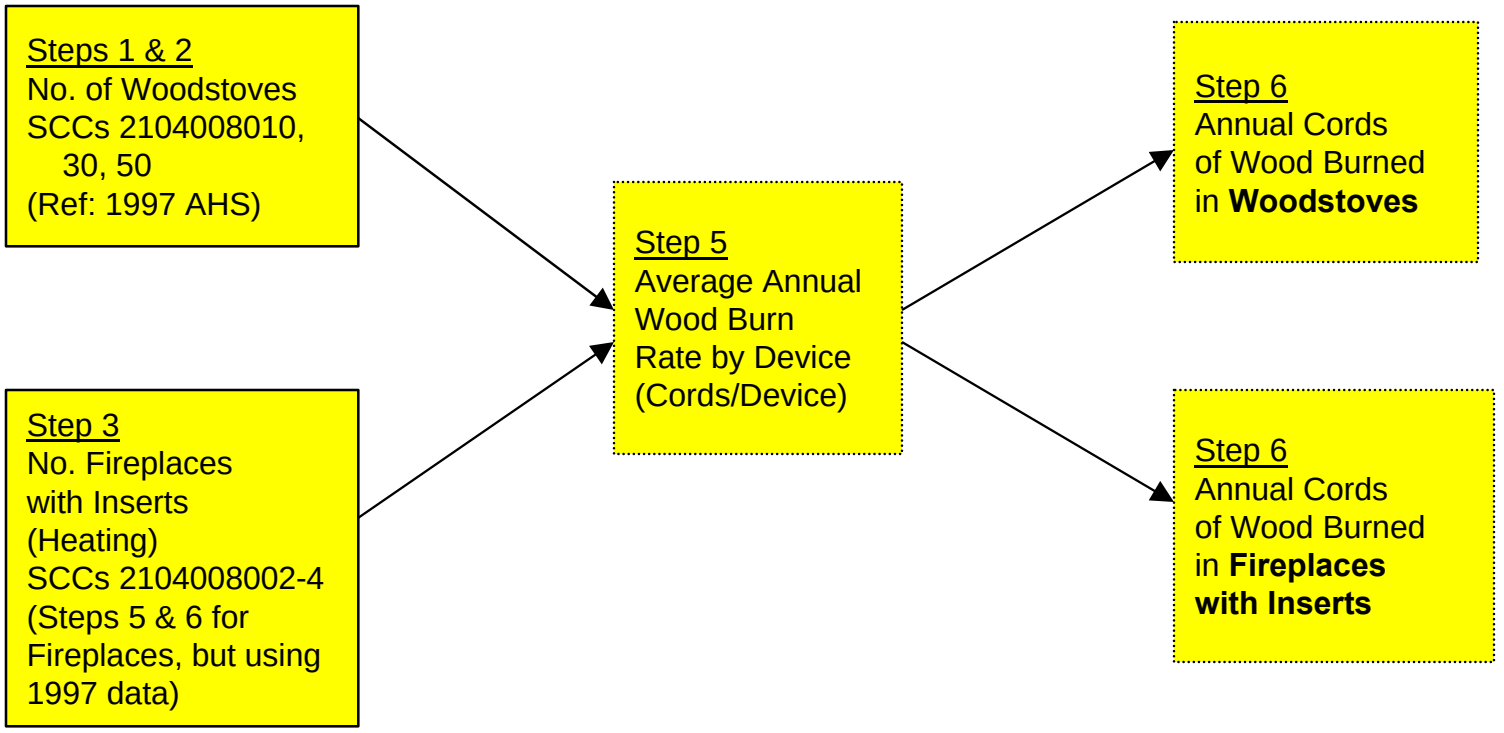
- **Step 8:** Determine number of homes with fireplaces without inserts used for heating
  - Used to determine the number of fireplaces without inserts used for aesthetic purposes
  - Reference: AHS for the United States in 1999 (U.S. Census Bureau)
- **Step 9:** Adjust to account for homes with more than one fireplace (multiply by 1.17)
  - Reference: 1989 U.S. Consumer Product Safety Commission report
- **Step 10:** Determine number of fireplaces without inserts used for aesthetic purposes (Step 4-Step 6)
- **Steps 11 & 12**:
  - Wood consumption rates for fireplaces with and without inserts based on data from source tests, local surveys, and market research studies

Flow Chart for Estimating Average Wood Burn Rates for Woodstoves and Fireplaces With Inserts



Reference: Houck, J.E., et al, A Recommended Procedure for Compiling Emission Inventory National, Regional and County Level Activity Data for the Residential Wood Combustion Source Category, NEI Conference, May 1-3, 2001

Flow Chart for Estimating Activity for Woodstoves and Fireplaces With Inserts



Reference: Houck, J.E., et al, A Recommended Procedure for Compiling Emission Inventory National, Regional and County Level Activity Data for the Residential Wood Combustion Source Category, NEI Conference, May 1-3, 2001

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- **Adjust 1997 Activity to 1999 Activity**
  - Woodstoves and Fireplaces with Inserts
    - Activity declined ~6.7%
    - Adjustment factor based on national 1997 & 1999 residential wood energy consumption data from Energy Information Administration

Spatial Allocation of National Residential Wood Consumption to Counties

- National wood consumption activity is estimated for:
  - Fireplaces with inserts
  - Fireplaces without inserts
  - Woodstoves
- National activity is allocated to counties using:
  - Climate zone (i.e., temperature)
  - Demographics/population (i.e., number of single-family homes)
  - Usage patterns for each device (i.e., urban versus rural)

Spatial Allocation of National Residential Wood Consumption to Counties (Cont.)

- **Apportion National Activity to 5 Climate Zones**
  - **Percentage of wood consumed in different climate zones**
    (Ref: EIA, "A Look at Residential Energy Consumption in 1997", Nov. 1999)

Climate Zone	Percent of Wood Consumed
1 (>7000 HDD)	36
2 (5500-7000 HDD)	19
3 (4000-5499 HDD)	21
4 (<4000 HDD and <2000 CDD)	15
5 (<4000 HDD and >2000 CDD)	9

  - **Climate zone designations for counties**
    - National Climatic Data Center data on annual Heating Degree Days (HDD) and Cooling Degree Days (CDD)

Spatial Allocation of National Residential Wood Consumption to Counties (Cont.)

- **Apportioning for Demographics/Population**
  - NEI methodology uses number of detached single-family homes (SFH) to apportion climate zone activity to counties (i.e., ratio of county to climate zone SFH totals)
    - For woodstoves & fireplaces with inserts, over 90% of wood consumption used for heating is in SFH
    - Fireplaces without inserts typically used in SFH
    - Reference for SFH data: 1990 U.S. Census
  - Previous methodology used population to apportion activity to counties
    - However, a county could have a large, concentrated population that does not correlate well with use of wood burning devices

Spatial Allocation of National Residential Wood Consumption to Counties (Cont.)

- **Urban/Rural Apportionment**
  - Designate each county as either urban or rural, sum activity for climate zone, and adjust county activity so climate zone total matches the following proportions:

	Rural	Urban
Woodstoves	69%	31%
Fireplaces with inserts	50%	50%
Fireplaces without inserts	32%	68%

  - Example: If the total wood consumption for woodstoves in climate zone 1 is 60 percent for rural and 40 percent for urban, then each urban and rural county within zone 1 receives a percent increase or decrease in cordwood consumption to obtain the correct percent split to reach the 69 percent rural and 31 percent urban split for zone 1.

Spatial Allocation of National Residential Wood Consumption to Counties (Cont.)

- **Designation of Counties as Urban/Rural**
  - 1999 U.S. Census data
  - Urban if >50% of county's population located in cities and towns
  - Rural if <50 percent of county's population located in cities and towns

- **Wood consumption for woodstoves and fireplaces with inserts were apportioned as follows:**

Type of Device	Percent of Total Wood Consumption
Non-certified	92
Certified non-catalytic	5.7
Certified catalytic	2.3

Temporal Allocation of Residential Wood Consumption Emissions

- Temporal allocation of emissions in NEI are by climate zone
  - These are default values, S/L/T agencies should adjust allocations to better fit seasonal usage patterns
- Seasonal throughput percentages assigned to each climate zone are:

Climate Zone	Winter	Spring	Summer	Fall
1	100	0	0	0
2	70	15	0	15
3	50	25	0	25
4	40	30	0	30
5	33.33	33.33	0	33.33

How are RWC Emissions Estimated in the '99 NEI (Cont.)?

- **Emissions Calculations**
  - Annual: Emission Factors Applied to County Activity
  - Ozone Season (June-Aug.=0 days of activity)
  - CO Season (Dec.-Feb.=90 days of activity)
    - (Annual x Winter Season Throughput)/90 days
    - Winter Season Throughput: 33.3 to 70% depending on climate zone
  - Rule Effectiveness = 100%
  - Rule Penetration = 100%
  - Control Efficiency = 0%
    - Effects of NSPS included in emission factors for woodstoves and fireplaces with inserts

How Can You Improve the NEI for Your Area?

- Prefer S/L/T agencies use their own data
- EIIP document for RWC
  (http://www.epa.gov/ttn/chief/eiip/pm25inventory/areasource.htm)
  - Preferred Method: Residential Wood Survey
    - Obtain locally representative information on the amount of wood fuel use specifically for woodstoves & fireplaces (with and without inserts)
    - This will require a local survey, or activity data generated by State & local governments
    - Reduces uncertainties in estimates associated with allocating national activity to counties
  - Alternative Method: Census Bureau and EIA Data Method
    - Use if resources are limited or emphasis is on preparing summer season inventory

How Can You Improve the NEI for Your Area?

- AP-42 has Specific PM10-PRI & CO Emission Factors for:
  - Pre-Phase I = Not certified to 1988 NSPS
  - Phase I = Certified to 1988 NSPS
  - Phase II = Certified to 1990 NSPS
  - Pellet Stoves (certified & exempt); Masonry Heaters (exempt)
- Rule Effectiveness/Rule Penetration
  - Incorporate effects of S/L/T rules and level of compliance
  - NEI methodology does not account for S/L/T rules

How Can You Improve on the NEI Methodology for Your Area?

- NEI Improvement
  - EPA is working on methodology to incorporate wax-based sawdust fire logs into activity estimates for fireplaces without inserts
- S/L/T agencies should provide comments on methodology to Roy Huntley (EPA/EFIG) 919-541-1060

RWC Data on Your CD

- Your CD contains an Access97 data base file named "RWC.mdb"
- This file contains the following county-level data used to prepare the draft 1999 NEI (Version 2.0) emission estimates:
  - State & County FIPS
  - SCCs and descriptions
  - Pollutants
  - Activity data (tons of dry wood) & conversion factor
  - Emission factors for criteria air pollutants and HAPs
  - Rule effectiveness, rule penetration, and control efficiency values
  - Seasonal throughput percentages/Climate zone assignment